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The use and benefits of Quick Response Codes for construction materials in South Africa

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Abstract

This article explores the use and potential benefits of Quick Response (QR) Codes on construction materials in an attempt to ensure that the construction industry continues to be more technologically advanced. This qualitative research study consisted of interviews and case studies. A sample of 30 construction material suppliers in the Durban region were purposively selected and interviewed, using a semi-structured interview schedule. Five case studies were randomly sampled from the Durban region where QR Codes were implemented for selected material samples. Knowledge, experience and the impact of QR Codes on construction materials were examined. The investigation chiefly found that most of the participants are in favour of the concept of using QR Codes, even though these are currently not widely used for construction materials in South Africa. Positive feedback was obtained from those participants who are using QR Codes on products. The findings provided the opportunity to improve the construction materials sector by introducing and implementing QR Codes as a technological advancement in the construction industry.

Keywords: QR Codes, construction industry, construction materials

Abstrak

Hierdie artikel ondersoek die gebruik en moontlike voordele van vinnige reaksie kodes (QR-kodes) op konstruksiemateriaal in 'n poging om te verseker dat die konstruksiebedryf steeds meer tegnologies gevorderd word. Die kwalitatiewe navorsingstudie het van onderhoude en gevallestudies gebruik gemaak.

Dertig konstruksiemateriaalverskaffers in die Durban-streek is doelbewus gekies en onderhoude is met hulle gevoer deur middel van 'n semi-gestruktureerde onderhoudskedule. Vyf gevallestudies is ewekansig uit die Durban-streek geneem waar QR-kodes vir geselekteerde materiaalmonsters geïmplementeer is. Kennis, ervaring en die impak van QR-kodes op konstruksiemateriaal is ondersoek. Die hoofbevinding van die ondersoek was dat meeste van die deelnemers ten gunste is van die gebruik van QR-kodering, alhoewel QR-kodes tans nie wyd vir konstruksiemateriaal in Suid-Afrika gebruik word nie. Deelnemers wat wel QR-kodes op produkte gebruik, het slegs positiewe terugvoer gegee. Die bevindings het die geleentheid gebied om die konstruksiemateriaalsektor te verbeter deur QR-kodes bekend te stel en te implementeer as tegnologiese vooruitgang in die konstruksiebedryf.

Sleutelwoorde: Konstruksiemateriaal, konstruksiebedryf, vinnige reaksie kodes

1.   Introduction

The construction industry is extremely important in South Africa. The economic development of South Africa can be measured using the construction industry as one of the indices (Mewomo & Maritz, 2015: 8). Construction projects are complex in nature and take place in an unprepared, uncontrolled and dynamic environment. Each project goes through several phases towards completion. Construction project completion relies on the participation of all contracting parties and resources. Construction materials are a project resource that influences the quality of construction projects (Wibowo, Elizar, Sholeh & Adji, 2016: 187). Real-time and accurate information is, therefore, required for sharing data among all the parties involved for the purpose of efficient and effective planning (Sardroud, 2012: 382). Currently, the construction sector has been slow to adopt new digital technologies (Fuchs, Nowcke & Strube, 2017: online). One of the reasons for this trend might be the fragmented landscape of this sector, which includes various stakeholders that can make it difficult to explore new technologies. Another reason might be that companies are unfamiliar with the new digital technology available (Blanco, Mullin, Pandya & Sridhar, 2017: online). According to McKinsey Global Institute (MGI) (2017), one of the many new digital technologies available to the construction sector is sensors and communication (NFC) technology (MGI, 2017: 100). These capture real-time data from crews, equipment, and stores, enabling contractors to streamline their supply chains, reconcile material plans with physical availability, and analyse productivity (MGI, 2017: 100). One such sensor and communication technology is Quick Response (QR) Codes (Price, 2013: 1-2).

Building and construction materials are the primary sources and activities that define the quality of engineering and construction structures (Gulghane & Khandvi, 2015: 59, Wibowo *et al.*, 2016:

185). Currently, the construction materials sector is estimated at approximately R95 billion per annum, with 60% sold directly to end-users, and 40% sold through a distribution channel, of which there are roughly 10,000 outlets countrywide. Approximately R17 billion (18%) is used for additions and alterations, as well as for the home-improvement market (CIDB, 2007: 21). Materials account for up to 60% or more of the total cost of a construction project, depending on the type of project (Gulghane & Khandvi, 2015: 59). Construction materials are, therefore, an extremely critical element in all construction projects and can make significant contributions to the cost effectiveness of projects. Planning and managing the logistics of materials is critical, as they directly affect the cost and schedule of a construction project (Sardroud, 2012: 381). Cost imbursements due to delays, rework and unnecessary work may be a result of the inadequate identification of materials, lack of materials when required, re-handling, and insufficient storage. Material management plays a significant role in the success of any construction project. The most significant fragment of material management is its identification and tracking (Sardroud, 2012: 381). Automation technology allows for speedy and accurate data transfer that managers can use to identify and track construction materials from different locations (Sardroud, 2012: 381). One such technology is the use of QR Codes to improve the identification, tracking, delivery, receipt, and location of materials and components (Sardroud, 2012: 383).

To explore the benefits of using QR Codes in the South African construction materials sector, this article determines how QR Codes could convey information for construction materials in South Africa, and how QR codes on construction materials can assist the South African construction industry in becoming more technologically advanced.

2. Literature review

The built environment requires an estimate of over 100,000 different types of materials for construction, operation, and maintenance. Materials such as cement in the form of concrete is one of the most heavily consumed materials on the planet, more so than even food or fuel (Skanska, 2017). To understand the purpose for applying digital and automation technology in the construction materials industry, it is important to introduce its concepts to those who work in the construction industry.

2.1   QR Codes defined

QR Code, an abbreviation for Quick Response Code, is a machine-readable two-dimensional barcode (Price, 2013: 1-2). QR Codes form part of the matrix (two-dimensional) barcode technology and are usually attached to items as they contain information about the items. QR Codes use four standardised encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently (Wave, 2016). The QR Code was created for conveying data faster and at a high speed (Weir, 2010: 12). Both Wave (2016) and Chang (2014: 114) mention that QR Codes are readable from any angle and are dirt and damage resistant. QR Codes have a small printout size, with high-capacity encoding of data and a structured appending feature, making it suitable to use on construction materials (Wave, 2016). QR Codes are currently in their third generation. The storage capacity did not only increase with each generation, but new features such as the addition of company logos on QR Codes were also added (Demir, Kaynak & Demir, 2015: 406-407).

Figure 1: First-generation QR Code (Demir *et al.*, 2015: 406)

Figure 2: Third-generation QR Code (Demir et al., 2015: 407)

2.2   The origin of QR Codes

QR Codes were first created by a Toyota subsidiary, Denso Wave, in 1994 (Weir, 2010: 11). According to Probst (2012: 2), Denso Wave developed the QR Code in an attempt to improve the manufacturing process and the tracking of vehicles and parts. QR Codes were designed to allow for fast decoding speeds and owe their existence to the development and success of barcodes (Wave, 2016).

In the 1960s, as barcodes were developed to help cashiers lighten their burden of manually keying in prices, their use spread. However, their limitations also became apparent in that a barcode can only hold 20 alphanumeric characters of information as the dominant factor. Users contacted Denso Wave Incorporated (then a division of Denso Corporation), who were developing barcode readers at that time, to develop barcodes that could hold more information. A development team embarked on a journey to develop these barcodes (Wave, 2016).

After announcing the release of the QR Code in 1994, it was adopted by the auto industry and contributed considerably to the efficiency of their management work (Wave, 2016). Denso Wave then decided to make the specifications of the QR Code freely available to the general public. Patent rights to the QR Code were retained by Denso Wave. However, he chose not to exercise them; the QR code could thus be used by as many people as possible at no cost (Chang, 2014: 113-114).

The use of QR Codes, which became widespread in Japan in 2002, was facilitated by the trend of marketing mobile phones with a QR Code-reading feature. The popularity of the code among the general public was due to its sheer convenience, as the QR Code is an open code that anyone is allowed to use (Wave, 2016).

2.3 Advantages and disadvantages of QR codes

2.3.1 Advantages

The main advantage of QR Codes is their versatility, which makes them very easy to use. They can be used for nearly anything and are beneficial for both customers and businesses (Estate QR Codes, 2016). QR Codes can store a great deal of information such as text, videos, advertisements, business card information, personal information, and any other type of digital information (Demir *et al.*, 2015: 406). QR Codes also combine different forms of marketing streams, thus maximising business exposure and generating more revenue (Estate QR Codes, 2016; Gramigna, 2016).

QR Codes are extremely cost effective, as there are no start-up costs or monthly fees, and many QR Code generators and readers are free (Price, 2013: 1-2). Using QR Codes can save paper, thereby displaying content in a green way (Price, 2013: 1-2). QR Codes are easily generated, can be customised to suit promotional items, provide an easier way to manage the return on investment of one's marketing presence, and allow effective learning about the audience's interests (Gramigna, 2016; QR Code Stickers, 2013).

2.3.2 Disadvantages

People's lack of familiarity with the QR Code is one of the biggest disadvantages. Although QR Codes can be found nearly anywhere, people do not know how to obtain the information they require (Estate QR Codes, 2016). The other major disadvantage is that a mobile device or a smartphone as well as a QR Code reader are required in order to gain access to a QR Code (Gramigna, 2016).

2.4   QR codes and their use for construction materials

In a typical construction-material outlet, customers choose a product either subconsciously or at a speed, because time is of the essence. The shopping environment can sometimes be disorderly and complex, causing shoppers to use clues such as familiar brands or pricing displays instead of finding the best option (Kappa, 2017: 6). Shelf-ready packaging is an effective way of applying digital technology such as bar codes to products, as shoppers react instantly to what they see in front of them (QR Codes for Innovative Product Packaging, 2017). Using barcode technology in construction-material stores allows for materials managers to keep a centralised record on a computer system that tracks products, prices, and stock levels (Woodford, 2017: online). Managers can change prices as often as they like, without having to put new price tags on all the items on the shelves. One can instantly see when stock levels of certain items are running low and reorder. It also allows customers to read information about the materials such as their specification, source, fitting instructions, maintenance data, storage requirements, and safety information (Kappa, 2017: 6). Because barcode technology is so accurate, customers can use their smartphone devices to scan these codes (Marketing Natural Products Using QR Codes, 2017). Scanned codes link these devices to websites where customers can review products, manufacturers, brands, and companies before choosing to buy the products. Another reason why QR codes are put on products is to ensure that buyers can participate in rewards programmes and are given discounts, free goods, and premium prizes. QR Codes on packaging have also been used for promotions and raffles (QR Codes for Innovative Product Packaging, 2017).

3.   Research methodology

With a focus on the impact of QR Codes on construction materials in the construction industry, this study originates from an interpretative paradigm and follows a qualitative research approach (Yanow & Schwartz-Shea, 2011). This type of paradigm allows for exploring and understanding the meaning individuals or groups ascribe to a social or human problem (Creswell, 2014; Mertens, 2009; Welman, Kruger & Mitchell, 2005). It also allows for adopting a qualitative research design that justifies the use of semi-structured interviews and case studies (Creswell, 2014: 17). In this study, semi-structured interviews used open-ended interviewing to explore the participants' views on the use of QR Codes in the South African construction-materials industry (Thanh & Thanh, 2015: 24). Various products from five

selected building-material suppliers were issued with QR Codes and used as case studies to test the effectiveness of using QR Codes in construction-material outlets (Creswell, 2005). Another reason for using a qualitative research approach is that it supports thematic data analysis, which is the process of identifying patterns or themes within qualitative data (*Creswell*, 2014; Clarke & Braun, 2013). In this study, thematic data analysis was used, because it is not tied to a specific theoretical perspective. This flexible method is used to present a detailed and nuanced account of data by transcribing, coding and setting themes from the interviews and case studies (Braun & Clarke, 2006: 87; Clarke & Braun, 2013).

3.1 Sampling

A total of 30 interviews were conducted with construction-materials suppliers in the Durban region. The sample consisted of suppliers from the following building-material products: tiles, paint, bricks and precast cement, glass, timber, carpets and flooring, trusses, electrical and lighting, blinds, as well as plumbing. The construction-material suppliers were selected by means of the purposively sampling technique, using availability and willingness to participate as criteria (Cresswell & Plano Clark, 2011).

The case studies selected for this study consisted of five construction-material suppliers. However, as QR Codes are relatively new in South Africa and many people may not know their nature or benefits, it was necessary to select the construction-material suppliers to be used for the study based on "who are easily available and convenient to interview". Therefore, five case study building-material suppliers were selected by means of the non-probabilistic convenience sampling technique and used as the source of data for this study (Etikan, Musa & Alkassim, 2016: 2). The suppliers used for the case studies were Corobrik, Precast Cement Products, Tile Africa, Timbercity, and Top Carpets & Floors.

3.2   Data collection

The QR Codes topics used in the interview survey were extracted from reviews of the literature. The interview survey contained open-ended questions. Respondents were asked to indicate the type of building construction material they supply: a) tiles, b) paint, c) bricks and precast cement, d) glass, e) timber, f) carpets and flooring, g) trusses, h) electrical and lighting, i) blinds, and j) plumbing. To understand the level of QR Codes technology in the construction-materials sector, respondents were asked to mention whether they knew what a QR

Code is; use QR Codes as a marketing tool; will continue to use QR Codes; can suggest other ways in which QR Codes can assist their company, and suggest implications with using QR Codes. Prior to the interviews, the researchers explained the following advantages and disadvantages of QR Codes to respondents: the way in which they can be incorporated in the construction-materials industry, and their effect on the industry. The researchers ensured that all participating interviewees were asked the same questions.

For the case studies, construction-material suppliers were selected where QR Codes could be implemented on products with the potential for testing the application and use of QR Codes and determining if they can make a positive difference in the industry. The researchers went to each supplier to obtain approval and were given samples of products on which to conduct the study. The researchers then collected information from the managers as well as from the websites and made the QR Codes for the sample products. After scanning the QR Code multiple times to ensure that it worked correctly, the researchers returned to the stores and inserted the QR Codes on the labels or placed them near the samples.

3.3   Data analysis and interpretation of the findings

Using thematic data analysis, a nuanced account of the data could be presented by transcribing, coding and setting themes from the responses of the interviews and case studies (Braun & Clarke, 2006: 87). The responses from the interview survey and case studies interviews with store managers and observations from customers form the data set for this study. Once all the responses in the data set were transcribed, codes could be generated and were set as: QR Codes general information; QR Codes as a marketing tool; QR Codes ease of use; QR Codes future use; QR Codes assist company, and QR Codes implications with use. From this set of codes preliminary themes were set as: QR Codes general information; QR Codes as a marketing tool; QR Codes use; QR Codes benefits, and QR Codes impact. Based on the entire data set, these codes were refined into three specific themes which are defined as: QR Codes convey information; QR Codes benefit the South African construction-materials sector, and QR codes on construction materials assist the South African construction industry to become more technologically advanced.

4.   Findings

4.1   Respondents

Respondents were asked to indicate the type of building construction material they supply. Table 1 shows the different suppliers from the sample that were used in the study.

Table 1:   Suppliers in the sample

Suppliers	Number
Tiles	5
Paint	3
Bricks and precast cement	2
Glass	1
Timber	5
Carpets and flooring	5
Trusses	1
Electrical and lighting	3
Blinds	2
Plumbing	3
Total	**30**

4.2   Interview analysis based on themes

4.2.1   QR Codes convey in♥formation

This theme captured the respondents' general knowledge and trends regarding the concept of QR Codes. Figure 3 shows the interviewees' general views on QR Codes.

Only one third of the interviewees knew what a QR Code is. After showing a picture of a QR Code and explaining to the twenty interviewees, who did not know what a QR Code is, the researchers found that only one respondent still did not know what it is. This shows that QR Codes are known, but that people do not necessarily know what it is called. Only 30% of the ten people, who knew what a QR Code is, are using them on products, while the other 30% use QR Codes for payments, advertising, or as a link to their website. This clearly indicates that, although some suppliers may use QR Codes, they have not yet experienced their full benefits.
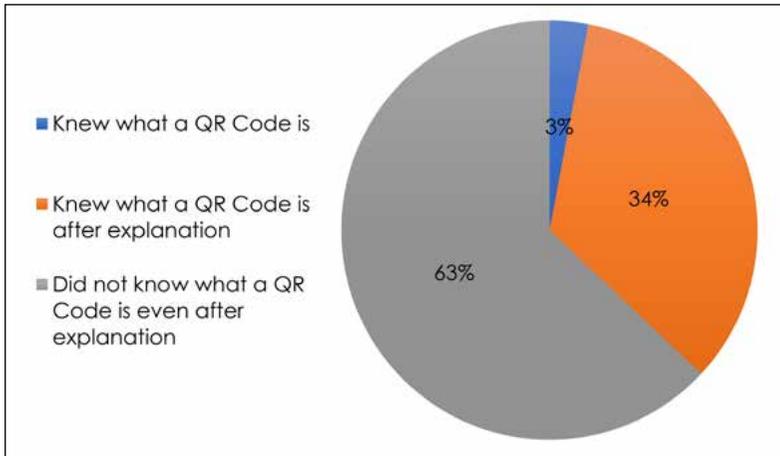
Figure 3:   Interviewees' view on QR Codes

4.2.2   QR Codes as a marketing tool

This theme captured the respondents' general knowledge regarding the concept of using QR Codes as a marketing tool.

When asked about the type of marketing tools their company currently uses, 74% of the respondents replied websites and print; 21% replied social media and television, and 6% replied by word of mouth. The literature review shows that different forms of marketing can be streamed together, as QR Codes can act as a link that exposes clients to many different ways of advertising the product. QR Codes can, therefore, maximise exposure and increase revenue.

Of the 24 interviewees who are not using QR Codes, only two did not see themselves using QR Codes as a marketing tool in the future for the following reasons: "customers already know what they are looking for when they come in the store". Six of the interviewees said "maybe". Sixteen interviewees perceived themselves as using QR Codes as a marketing tool in the future for the following reasons:

> *The company tries its best to keep up with technology.*

> *I will know that it has been brought to my attention.*

> *QR Codes are the next big thing.*

> *It will definitely help.*

> *I was just in a meeting about better ways to market and communicate, so QR Codes have definitely given me an idea.*

4.2.3 QR Codes use

This theme captured the respondents' knowledge regarding the concept of using QR Codes in general in their companies. Table 4 shows the reason why some interviewees do not use QR Codes.

The suppliers who were not using QR Codes were then asked why they were not utilising them. Some (12.5%) mentioned that they do not see the need for it; 29.5% of them were not sure, and 58% stated that "*it has not been introduced*"; "*they haven't thought about it*", or "*the lack of knowledge about it*". This indicates that more marketing about QR Codes and their benefits must be explained before they can be adopted in a company.
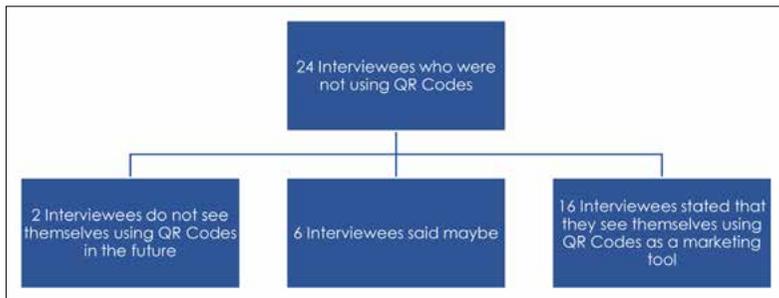

Figure 4: The reasons for some interviewees not using QR Codes

The interviewees, who are using QR Codes, were then asked if they see the company continuing to use QR Codes. A particularly happy respondent mentioned:

> *We have been using QR Codes for the past 8 years and it has really made a difference. It brought in a lot of business and clients are extremely satisfied with the company and the idea of being technologically advanced. QR codes are very attractive and clients always notice them and ask more about them. This makes them scan QR Codes. Therefore, I definitely see us continuing to use QR Codes as a marketing tool in the future.*

The interviewees were asked if there are any implications of using QR Codes. Of the interviewees, 80% stated that there are no implications, while 20% believed that there are implications. The following explanations were given for the implications:

> *Sales representatives will no longer be needed.*

> *Specifications on the QR Code may be found in the hands of competitors and lack of skills training as not everyone is technologically orientated.*

4.2.4 QR Codes benefits

This theme captured the respondents' knowledge of the ways in which the use of QR Codes can benefit their companies.

The respondents also discussed other ways in which QR codes can assist the company, including the following responses:

> *Brand awareness.*
>
> *To assist with making more money and bringing in business.*
>
> *Marketing.*
>
> *Advertising.*
>
> *For compliance, as the respondent believed that they fail in this regard. QR Codes can now be stamped on the product for effective tracking and communication.*
>
> *On websites.*
>
> *As a payment method.*

When asked about the benefits of using technology in construction, the following responses were received:

> *Bringing in more business.*
>
> *Being easier.*
>
> *Saving time and paper.*
>
> *Upgrading equipment and software.*
>
> *Testing materials.*
>
> *Cutting out human error.*
>
> *Assisting with safety regulations.*
>
> *Assisting the entire construction process.*

The literature review indicated that QR Codes are a technological advancement of barcodes and thus a quick and efficient way to move information.

4.2.5 QR Codes impact

This theme captured the respondents' knowledge on the possible impact of the use of QR Codes on the building and construction industry. Figure 5 shows the interviewees' views on the current state of the South African construction industry.

Of the respondents, 70% believe that QR Codes are in fashion. This implies that QR Codes are known and can certainly make an impact in the industry. Twenty-five respondents believed that QR Codes is a trend set to grow.
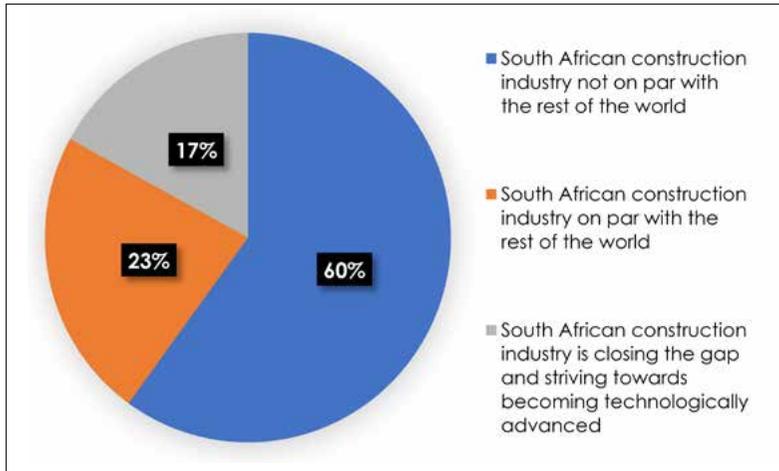

Figure 5:   The interviewees' views on the current state of the South African construction industry

The suppliers who were using QR Codes were asked if they measured the impact of QR codes. The following responses were provided:

No, as we just started using QR Codes.

It is definitely working.

It is effective.

It brought in business.

A positive response was received when asked about whether QR Codes can impact on construction materials in South Africa, with one of the respondents, who is currently using QR Codes, stating that "*it impacted this company tremendously ...*", thus indicating unanimously that the interviewees believe that QR Codes are the way forward for South Africa's construction-materials sector.

Of the respondents, 90% believe that QR Codes should be implemented in the South African construction-materials sector. "*They MUST*", emphasized one respondent. A negative comment was that "*QR Codes should not be implemented in the construction materials sector of South Africa because there is no need for it.*"

4.3   Analysis of case studies

Using the same preliminary themes, the analysis from the case studies is discussed under each of them, but without headings: QR Codes general information; QR Codes as a marketing tool; QR Codes use; QR Codes benefits, and QR Codes impact.

4.3.1   Corobrik

Corobrik is a manufacturer and supplier of face bricks, non-face bricks, clay pavers, concrete, masonry, pavers, and earth retaining systems (Corobrik, 2017). The researchers visited Corobrik and, upon obtaining the required approval, were given a sample of two bricks to conduct the study on namely Firelight and Nebraska. The researchers then collected information from both the manager of the store and the website and made the QR Codes fit on the label found in store. After scanning the QR Code multiple times to ensure that it is in correct working order, the researchers went to Corobrik and inserted the QR Codes on the labels of Firelight and Nebraska.

After using the QR Codes consistently for 20 days, Corobrik found that it was extremely quick and easy to scan and install the application. The responses from the interviews concerning the use of the QR codes were only positive ones; there were no complaints about the QR Codes. After seeing the QR Codes in action, the staff believed that there more signage should be provided, enabling more customers to take an interest in the QR codes. They opine that the QR Codes require a great deal of visibility to realise their full benefits. Corobrik liked the idea of QR Codes and the staff can view QR Codes as a permanent marketing tool in the company. Corobrik believes that QR Codes can assist the industry, as it is part of technology, which plays a big role in today's world.

4.3.2   Precast Cement Products

Precast Cement Products supply concrete blocks to both the domestic and the industrial market and specialise in textured and coloured face blocks with a range of 13 colours (Precast Cement Products, 2017).

After gaining the required approval from the manager of Precast Cement Products, the researchers were given a sample of two blocks, namely Fairface Blocks and Splitface Blocks. The manager indicated that he would like the QR Codes to be framed, due to the lack of space in the shopfront. The researchers then collected information from both the manager of the store and the website. They fitted the

QR Codes in an A5 frame, as requested by the store manager. After scanning the QR Code multiple times and with multiple QR Code readers to ensure their correct operation, the researchers contacted Precast Cement Products and placed the frame on the shopfront.

After having the QR Codes in the shopfront for 20 days, Precast Cement Products were happy with the effect QR Codes had on the company. They received no complaints; they thought that it was easy and effective to use, and they believed that they need to get more people involved in technology. They opined that it would assist their company if they get more people involved with scanning QR Codes. The only improvement they would like to make to the QR Code to increase its effectiveness is to insert pictures on the QR Code. Precast Cement Products is of the opinion that QR Codes will assist the industry when there is a shortage of staff and when customers are left waiting for a sales representative. The customers can simply scan the code and obtain the information they require.

4.3.3 Tile Africa

Tile Africa supplies local and imported floor and wall tiles in ceramic, polished or glazed porcelain, natural stone, slate, or decorative tiles (Tile Africa, 2017). Upon the required approval, a sample of two tiles, namely Houtbay Weathered and Houtbay Bleached, were used to conduct this study at Tile Africa. The store manager then emailed the required information he wished to have on the QR Code to the researchers. He wanted the QR Codes to fit in the label of the required tiles. The researchers then made the QR Codes and scanned them to ensure that they are operating correctly. The researchers then inserted the QR Codes on the labels of Houtbay Weathered and Houtbay Bleached.

Tile Africa used the QR Codes consistently for 20 days. Customers noted that the QR Codes were extremely easy to use. Tile Africa did not experience any problems in using them and had no suggestions for further improvement. The customers were curious about what the QR Code was about. This shows that QR Codes are attractive and catch the eye of people. Going forward, the company believes that it would be much easier to have a great deal of data accessible regarding specifications and technical information. Sales consultants can also use these codes to access information and confidently answer customers' questions. Tile Africa believes that QR Codes can assist the construction industry if used by the right people, in the right way and for the right purpose. They agreed to have QR Codes on all their products.

4.3.4 Timbercity

Timbercity specialises in timber, board as well as hardware for cabinetry and carpentry. Related services such as board cutting, edging and the pre-drilling of hinge holes are also provided (Timbercity, 2015).

After obtaining the required approval from Timbercity, the researchers were given a sample of nine types and lengths of timber to conduct the study, namely 20x20 pine plain all round 1,800mm, 20x20 pine plain all round 2,400mm, 20x20 pine plain all round 3,000mm, 32x32 pine plain all round 1,800mm, 32x32 pine plain all round 2,400mm, 32x32 pine plain all round 3,000mm, 20x64 pine plain all round 1,800mm, 20x64 pine plain all round 2,400mm, and 20x64 pine plain all round 3,000mm. Information was collected from the store manager and the QR Codes were made to fit on the label found in store. After scanning the QR Code multiple times, the researchers went to Timbercity and inserted the QR Codes on the labels of the required timbers.

After having used the QR Codes for 20 days, Timbercity were of the opinion that the QR Codes are easy to use and that they have no complaints. They believe that the QR Codes were the ideal size for their company. So far, QR codes give customers more information. However, more advertising would have to be made available for customers to refer to. Self-service in Timbercity is a great help, as customers do not need the attention of a sales assistant to obtain information about a product.

4.3.5 Top Carpets and Floors

Top Carpets and Floors offer a wide range of carpets, laminates, vinyls, ceramic tiles, other floor coverings, and blinds (Top Carpets and Floors, 2017).

After obtaining the required approval, the researchers placed QR Codes on two types of laminate floors (Elegant Living and Liberty) at Top Carpets and Floors. The store manager then showed the researchers the required information to be placed on the QR Code from the website. He wanted the QR Codes to be on an A4 page, as the laminate flooring was displayed on the floor of the store. The manager intended to have the A4 page kept at the sales representatives' desk near the laminate flooring. The researchers extracted the required information from the website and made the QR Codes. They then tested QR Codes several times with several

different QR Code readers to ensure their correct operation and handed these over to the store manager.

The QR Codes were placed on pages on the sales consultant's desk and not on labels or displayed for customers to view. Top Carpets and Floors did not use the QR Codes consistently for 20 days. They did admit that the QR Codes are easy to use and that the customers did not experience problems when scanning them. However, they realised that having it displayed would elicit more feedback. Top Carpets and Floors can perceive the company using QR Codes in the future, but these will have to be more visible to get their full benefit. They believe that QR Codes can assist the industry by providing much needed information to customers.

4.3 Final analysis and discussion

Based on the results from the entire data set, three specific themes are defined and discussed: QR Codes convey information; benefit the South African construction-materials sector, and assist the South African construction industry in becoming more technologically advanced.

4.3.1 QR Codes convey information

This theme captured the respondents' existing knowledge on how QR Codes can help the construction industry convey information, by including as much information as possible to ensure effective communication and information-sharing.

During the interviews, the majority of the respondents expressed a positive experience with using QR Codes to convey information to customers:

> QR Codes are the next big thing.

> I was just in a meeting about better ways to market and communicate, so QR Codes has definitely given me an idea.

> I definitely see us continuing to use QR Codes as a marketing tool in the future.

> QR Codes can now be stamped on the product for effective tracking and communication.

The managers of the stores in the case studies believed that QR Codes can convey information; they expressed a positive experience during the trial period when using QR Codes on their products.

Precast Cement Products: "*The customers can simply scan the code and gain the information they require*".

Tile Africa: "*… it would be much easier to have a lot of data accessible regarding specifications and technical information. Sales consultants can also use these codes to access information and confidently answer customers' questions.*"

Top Carpets and Floors: "*… QR codes are working by giving customers more information.*"

The literature review shows that QR Codes convey information horizontally and vertically. Therefore, these codes store hundred times more information than normal barcodes (Chang, 2014: 114). QR Codes on products give customers a good reason to buy a product, as it can provide additional information as well as photos, videos and demos with user reviews, without crowding a store to ensure customers can confidently buy a product (QR Code Stickers, 2013).

The essential point is that the respondents had a positive experience and supported the use of QR Codes to convey information – for example, feeling positive – because they experienced that information can be sourced quickly and easily; information of products can easily be punched into a QR Code creator, which will then create the QR Code for fast and effective marketing and information-sharing; QR Codes eliminate human error, as a sales representative may forget an important feature or may mix up two products; customers obtain the correct information at the click of a button, and customers no longer need to wait to talk to a sales representative for product information, thus saving time.

4.3.2   QR Codes benefit the South African construction-materials sector

This theme captured the respondents' existing knowledge on the benefits of using QR Codes in the South African construction-materials sector.

During the interviews, the majority of the respondents expressed positive views on the benefits of using QR Codes and on the ways in which QR Codes can assist companies in the construction-materials sector:

> *It brought in a lot of business.*

> *Cutting out human error.*

> *Assisting with safety regulations.*

> *Brand awareness.*

For compliance - QR Codes can be stamped on products for effective tracking and communication.

Marketing and advertising.

As a payment method.

Saving time and paper.

The managers of the stores in the case studies believed that QR Codes can benefit their companies. They also expressed a positive experience during the trial period when using QR Codes on their products.

Corobrik: "*QR Codes need a lot of visibility so that the full benefits can be realised.*"

Precast Cement Products: "*We are happy with the effect QR Codes had on the company … if more people scan QR Codes, it will assist our company.*"

Precast Cement Products & Timbercity: "*… QR Codes will assist the industry if there is a shortage of staff and customers are left waiting for a sales representative. The customers can simply scan the code and gain the information they require.*"

Top Carpets and Floors: "*… can see the company using QR Codes in the future but with it being more visible to get the full benefit of it … QR Codes can assist the industry by providing much needed information to customers.*"

The literature review indicates that QR Codes can benefit the construction-materials sector, because QR Codes are versatile, user friendly and easy to use (QR Code Stickers, 2013). Generators and readers are free to install and, once the application is downloaded, QR Codes can be made by anyone and put anywhere, as they are relatively small in size (QR Code Stickers, 2013). There are no start-up costs or monthly fees, thus making QR Codes extremely cost effective (Price, 2013: 1-2).

A great deal of information can be stored on the code (Demir *et al.*, 2015: 406). Different forms of marketing can be streamed together, as QR Codes can act as a link that exposes clients to many different ways of advertising the product or service. QR Codes can maximise exposure and produce revenue (Estate QR Codes, 2016). Responses on QR Codes can easily be tracked, based on specific objectives (Gramigna, 2016). The use of QR Codes eliminates the gap between offline print and online pages, thus saving paper and displaying information in a green way (Price, 2013: 1-2).

The important point is that the managers had a positive experience and supported the benefits of using QR Codes on construction materials not only for their stores, but also for the construction industry – for example, feeling positive – because they experienced that QR Codes can assist with brand awareness, marketing, advertising as well as a payment method. For compliance, QR Codes can be stamped on the product to ensure effective tracking and communication; bring in business, as they are attractive and customers want to know more about them when they see them; have made companies grow, extend themselves to the world with information that is accessible anywhere, and set themselves apart from the rest; are quick, easy and simple; eliminate human error; make a sales representative's job easier, and is a great tool for marketing and information-sharing.

4.3.3 QR codes on construction materials help the South African construction industry become more technologically advanced

This theme captured the respondents' existing knowledge on how the use of QR Codes on construction materials can help the South African construction industry become more technologically advanced.

During the interviews, the majority of the respondents expressed positive views on how the use of QR Codes on construction material can help the construction industry be more technologically advanced:

> *Easier store management.*
>
> *Easier to click a button for information.*
>
> *Saving time and paper.*
>
> *Upgrading equipment and software.*
>
> *Preview materials.*
>
> *Cutting out human error.*
>
> *Assist the entire construction process.*
>
> *The company tries its best to keep up with technology.*
>
> *Clients are extremely satisfied with the company and the idea of being technologically advanced.*

The managers of the stores in the case studies believed that QR Codes on construction material can help the South African construction industry become more technologically advanced; they also expressed a positive experience during the trial period when using QR Codes on their products.

Corobrik: "… *QR Codes can assist the industry as it is part of technology and technology plays a big role in today's world*."

Precast Cement Products: "… *we are happy with the effect QR Codes had on the company… we will get more people involved in technology*."

The literature review indicates that QR Codes on construction material can help the construction industry become more technologically advanced, because using QR Code applications allows the industry to use matrix barcode technology and machine-readable barcodes that have advanced storage capacity (Demir *et al.*, 2015: 406).

The widespread use of QR Code reading features on mobile phones made it easier for the construction industry to use the advanced features of QR technology. QR Codes use a software programme that is installed on smartphones to create, read and analyse the codes. Once the software analyses the code, the necessary information and actions are displayed on the screen (Chang, 2014: 114).

The essential point is that the respondents had a positive experience and support the display of QR Codes on construction material to help the construction industry become more technologically advanced – for example, feeling positive – because they experienced that QR Codes are extremely technologically advanced; are completely digital, and are created, read and analysed with the click of a button, and there is no waiting time, as the code is created within seconds. QR Codes can assist the industry in becoming more technologically advanced by moving away from paper. Customers would no longer need to ask sales representatives for information, as they can simply click a button and scan the QR Code to access information at their fingertips.

5.   Conclusion

QR Codes have the potential to take the construction industry to greater heights, not only by providing information at the click of a button, but also by being simple, easy, cost effective and technologically advanced. QR Codes ensure that customers have valuable information at all times. The use of QR Codes eliminates human error. With QR Codes, information is accurate, true and reliable.

This article described QR Codes as a technological advancement of the construction-materials sector. The findings show that the respondents are in favour of QR Codes and would like to adopt QR

Codes as a marketing tool on products, even though QR Codes are not currently widely used for construction materials. The case studies show that, once QR Codes are adapted in the company, it has the potential to make great strides towards becoming technologically advanced.

In conclusion, it is recommended that stakeholders implement QR Codes on some, if not all of their products, in order to gain a perspective of whether QR Codes can work for them and the products they supply and to reap the benefits described earlier. It is further recommended that this study be done over a longer period, in order to track QR code usage and its effectiveness in the industry.

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